Annex

(a) Constructing a Trade Interconnectedness Index

The trade interconnectedness index (TII) is the weighted average of indicators capturing the importance of bilateral trade between countries for a group of N countries. The weight reflects the closeness of trade relationships.

Specifically, the TII for country i is $TII_i = \frac{1}{N-1}\sum_j \frac{1}{closeness_{ij}}\ importance_{ij}$, where $importance_{ij}$ is the average of nine indicators gauging the importance of bilateral trade between country i and j, and $closeness_{ij}$ is the measurement of how directly two countries trade with each other.

The $importance_{ij}$ indicator is composed of nine different criteria, eight of which measure the importance of imports and exports relative to an individual country's economy as well as to that of trading partners. These include:

1. M_{ij}/Y_i and M_{ji}/Y_j
2. X_{ij}/Y_i and X_{ji}/Y_j
3. $(M_{ij}/M_i)/(Y_j/\overline{Y}_{\sim i})$ and $(M_{ji}/M_j)/Y_i/\overline{Y}_{\sim j})$
4. $(X_{ij}/X_i)/(Y_j/\overline{Y}_{\sim i})$ and $(X_{ji}/X_j)/Y_i/\overline{Y}_{\sim j})$,

where M_{ij} (X_{ij}) is imports (exports) of country i from (to) country j; M_i (X_i) is imports (exports) of country i; Y_i is GDP of country i; and $\overline{Y}_{\sim i}$ is aggregate GDP of all other countries except country i.

These individual indicators take the value of 1 (otherwise 0) when the underlying measurement exceeds the specified threshold, which is set at the 75th percentile for each criterion.

For the ninth criterion, the indicator is based on the size of bilateral trade: $(M_{ij} + X_{ij})$ relative to trade of all countries. For this indicator, the threshold is set at the 90th percentile to capture only substantial bilateral trade pairs.

The $closeness_{ij}$ measurement is based on the notion of how directly countries are connected through trade. The construction of this measurement consists of two steps.

The first step is to specify what could be considered an important trade linkage. The analysis takes the view that a bilateral trade linkage between country i and country j is important if the $importance_{ij}$ indicator takes the values of at least $4/9$ (that is, four criteria specified above must be met). Then, two countries may be connected directly, or their connection may occur through third countries.

The second step is to count the distance between country i and country j, which in turn provides the value of $closeness_{ij}$, being defined as the inverse of the shortest distance. For example, if two countries share an important bilateral trade linkage and are thus connected directly, the shortest distance is 1 and the closeness is also 1. In contrast, if two countries are connected only through another country that has important trade linkages to both, the shortest distance is 2 and the closeness is ½.

Once both $importance_{ij}$ and $closeness_{ij}$ are constructed, the TII can be computed. This can be done for any specific group of countries. For instance, when the degree of trade interconnectedness of Europe as a whole is of interest, the TII is calculated based on all European countries. On the other hand, when the degree of trade interconnectedness with Central Europe is of interest, the TII is calculated with respect to countries in Central Europe (that is, computing the weighted average of $importance_{ij}$ where j represents all countries in Central Europe).

(b) Quantifying Output Spillovers through the Trade Channel

The analysis aims at quantifying the magnitude of output spillovers through the trade channel based on the structure of bilateral trade relationships within the region.

The analysis relies on two key assumptions. One is that the export multiplier (that is, the magnitude of output change due to export change) is equal to 1; thus, the analysis does not account for additional output spillovers within the economy, leakages of domestic demand to imports, and intermediate imports essential for production. Another is that additional output spillovers across countries are not considered.

The analysis estimates the percentage change in output in country i owing to a 1 percent change in output in country j, which is denoted by $s_i|_j = \left(\frac{\Delta Y_i}{Y_i}\right) / \left(\frac{\Delta Y_j}{Y_j}\right)$, where Y_i and Y_j are output in country i and j, respectively.

Based on the assumption of unitary export multiplier, the change in output in country i results from the change in exports from country i to country j (owing to a change in output in country j), which is, in fact, imports from country i by country j. Then, $\left(\frac{\Delta Y_i}{Y_i}\right) = \theta_{ji}\left(\frac{\Delta M_j}{Y_i}\right) = \theta_{ji}\left(\frac{Y_j}{Y_i}\right)\left(\frac{\Delta M_j}{Y_j}\right) = \theta_{ji}\left(\frac{Y_j}{Y_i}\right)\left(\frac{M_j}{Y_j}\right)\left(\frac{\Delta M_j}{M_j}\right)$, where θ_{ji} is country j's share of imports from country i and M_j is imports of country j.

Hence, $s_i|_j = \left(\frac{\Delta Y_i}{Y_i}\right) / \left(\frac{\Delta Y_j}{Y_j}\right) = \theta_{ji}\left(\frac{Y_j}{Y_i}\right)\left(\frac{M_j}{Y_j}\right)\varepsilon_j^M$, where ε_j^M is the output elasticity of imports, that is, $\varepsilon_j^M = \left(\frac{\Delta M_j}{M_j}\right) / \left(\frac{\Delta Y_j}{Y_j}\right)$. The value of $s_i|_j$ can be computed based on the structure of bilateral trade relationships reflected by θ_{ji}, the relative output ratio Y_j/Y_i, the import to GDP ratio M_j/Y_j, and the estimate for the output elasticity of imports ε_j^M. This is simply the regression coefficient of the percentage change in real imports on the percentage change in real GDP.

The analysis calculates the values of $s_i|_j$ for countries in Europe as well as in the Asia and Pacific region. Figure 4.14 presents the magnitude of output spillovers as a result of a 1 percent increase in output in all other countries in each region. This is simply the sum of $s_i|_j$ over all countries j.

(c) Growth Spillovers in a VAR Framework

The growth spillovers between Western Europe (WE) and CESEE are examined using a standard VAR framework containing quarterly real GDP growth for the sample period of 1997:Q2–2011:Q1, controlling for growth shocks that originated in the rest of the world (ROW). All major countries outside Europe are included in the VAR model to make sure that the estimated impulse responses purely reflect the spillovers between Western Europe and CESEE rather than reflecting similar responses to common global shocks.

For the purposes of this analysis, ROW includes the United States, emerging Asia (China, Hong Kong SAR, India, Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan Province of China, and Thailand), Japan and all other economies in the IMF's global projection model (Argentina, Australia, Brazil, Canada, Chile, Colombia, Israel, Mexico, New Zealand, Peru, South Africa, and Venezuela). PPP-based weights are used to construct the aggregate growth rates of ROW.

The following VAR models are estimated:

VAR-I: [*ROW*, *WE*, *CESEE*], and

VAR-II: [*ROW*, *WE*, *CE*, *CESEE* excluding *CE*].

The VAR-I system is estimated to study the spillovers between Western Europe and CESEE (Figure 4.15, left panels). The VAR-II model serves to examine the growth linkages between Western Europe and Central Europe (CE) on the one hand, and Western Europe and rest of CESEE, on the other hand (Figure 4.15, right panels).

The identification of the estimated shocks is achieved using Cholesky decompositions (that is, standard recursive ordering), and results presented in the text used the ordering of the countries indicated above. Robustness analysis for the result employing the methodology proposed by Bayoumi and Swiston (2008) was also carried out. More specifically, alternative orderings among countries were considered, and "averaged" impulse responses were calculated. The results are not affected by alternative orderings.

The model is estimated with five lags to ensure absence of autocorrelation in the estimated residuals. The results with four lags, which are more standard in the literature using quarterly data in the estimation of VAR models, yield quantitatively similar results.

(d) Credit Spillovers

The role of western bank lending to CESEE in the credit boom-bust cycles (Panel VAR-I) and the relationship between real credit growth and real economic activity growth (real GDP growth, real domestic demand growth, and real import growth) in CESEE (Panel VAR-II) are studied using a Panel VAR approach.

The baseline scenario considers 15 CESEE countries (Belarus, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, the Slovak Republic, Slovenia, Turkey, and Ukraine) and estimates the Panel VAR model using the least square dummy variable (LSDV) method between the 2003:Q1–2010:Q4 periods.[58]

PANEL VAR-I:

This model aims at characterizing the relationship between western bank lending and private credit expansion in CESEE. The first stage Panel VAR model, estimated with country-specific dummies using two lags, is as follows (for i = country index and t = 2003:Q1–2010:Q4):

$$CY_{i,t} = \alpha_i + \beta_1 CY_{i,t-1} + \beta_2 CY_{i,t-2} + \gamma FY_{i,t} + \varepsilon_{i,t},$$

where $CY_{i,t}$ is the quarterly change in private credit relative to GDP, and $FY_{i,t}$ is the quarterly change of BIS-reporting banks' exposure to CESEE banks relative to GDP.

PANEL VAR-II:

The second step of the analysis studies the relationship between real credit growth and real economic activity.

The second stage Panel VAR model, estimated with country-specific dummies using two lags, is as follows (for i = country index and t = 2003:Q1–2010:Q4):

$$Z_{i,t} = \delta_i + \pi_1 Z_{i,t-1} + \pi_2 Z_{i,t-2} + \rho C_{i,t} + \nu_{i,t},$$

where $Z_{i,t}$ is quarterly growth of real economic activity, and $C_{i,t}$ is quarterly growth of real private credit.

58 Other CESEE countries are not considered because of data unavailability.